<Poster Presentation 2>Lagrangian coherent structures at the onset. of permanent spatiotemporal chaos in the 2D Navier-Stokes equations

AUTHOR(S):

Miranda, Rodrigo A.; Rempel, Erico L.; Chian, Abraham C.-L.; Toledo, Benjamin A.

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Rodrigo A. Miranda[1], Erico L. Rempel[1], Abraham C.-L. Chian[1,2,3], Benjamin A. Toledo[1]

[1] *Institute of Aeronautical Technology (ITA) and World Institute for Space Environment Research (WISER), São José dos Campos-SP 12228-900, Brazil, rmiranda@ita.br*

[2] *National Institute for Space Research (INPE) and World Institute of Space Environment Research (WISER), São José dos Campos-SP 12227-010, Brazil*

[3] *California Institute of Technology, Pasadena, CA 91125, USA.*

Transition to permanent spatiotemporal chaos (STC) in one-dimensional models of nonlinear waves in fluids and plasmas has been studied in a series of papers [1, 2, 3, 4]. In this work we identify a transition from temporal chaos to STC in numerical simulations of the two-dimensional Navier-Stokes equations with periodic boundary conditions and a spatially-periodic external forcing. We keep the amplitude of the external forcing at a fixed value and choose the Reynolds number as the control parameter. We focus on the change in chaotic mixing properties of the fluid via detection of Lagrangian coherent structures (LCS), which act as transport barriers [5]. Two independent techniques, finite-time Lyapunov exponents (FTLE) [5] and distinguished trajectories (DT) [6], are used to detect LCS before and after STC. Before the onset of STC the fluid is characterized by spatially regular patterns dominated by large-scale long-lived vortices. After the onset of STC the flow displays spatiotemporal intermittency, in which regular patterns are suddenly interrupted by bursty behaviors that quickly destroy the large-scale vortices. The detection of LCS demonstrates a higher degree of flow complexity and enhanced chaotic mixing after transition to STC. These results can contribute to our understanding of transport and chaotic mixing processes of passive scalars in turbulent flows.

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